



Towards Green Cities in China and Germany

Options for integrating urban ecosystem services and biodiversity into policy and planning

Executive Summary

Today more than half of the world's population lives in cities, and by 2050 two thirds of mankind are expected to live in cities. In times of climate change and biodiversity loss, sustainable city planning is more important than ever, in rapidly growing and new cities as much as in old cities in need of adaptation.

Policy Message

- leaf Green Cities are an indispensable contribution to an ecological civilisation, to national sustainable development.
- leaf This requires rethinking of urban development concepts at all levels, understanding that the integration of urban biodiversity and urban ecosystems into urban planning strategies is essential for human well-being and the sustainable development of agglomerations.
- leaf Case study examples from China and Germany of urban green spaces and biodiversity being integrated into the city development show the contribution of nature-based solutions to air quality improvement and climate change adaptation and mitigation and often provide cost-effective alternatives to technological options!

"Cities are where the battle for sustainable development will be won or lost"
(Post-2015-Agenda of UN)

Current approaches in need of rethinking

- leaf Urbanization and re-densification: Assure that built-up land does not grow at the expense of agricultural or protected areas. Enforce the legal provisions in China and the government objective of reducing land transformation in Germany. Safeguard the green space in and around cities – they are essential for clean air, fresh water, climate regulation, stormwater management and citizen leisure.
- leaf Economics: When calculating the costs and benefits of urban green spaces, take a comprehensive approach including citizen satisfaction, health, cultural and financial arguments; consider the multiple effects and pay attention to them in decision making.
- leaf Engineering: consider nature-based solutions as much as technical ones, assess their multiple benefits systematically and across different sectors.

Challenge: Growing Cities but Limited Resources

Cities are growing worldwide – in their spatial extent, concerning their total population and with respect to their general and actual macro-economic significance. This is particularly true for the numerous global growth centres in Asia. In this process, the use of land for development projects and the resource utilization are increasing in and around agglomeration centres but so are requirements for a good quality of life and a healthy urban environment. Even if the precise content of keywords like "Green City", "Eco City", "Smart City" or "Sponge City" is controversial, they have in common that green-blue infrastructure (city forests, river systems and lakes, parks and gardens, roof and wall greening etc.) make up a significant part of the quality of life in cities. They satisfy demands of urban dwellers, provide numerous ecosystem services such as supporting the adaptation to climate change impacts, provide support for biodiversity and are essential for the urban population in terms of environmental education and experience with nature.

But, is urban nature development consistent with a compact city which is argued to be a sustainable urban form to reduce urban sprawl and the consumption of resources within the city and its fringes? Is it possible to reconcile modern urban living, a growing infrastructure and attractive work and recreational opportunities with preservation of biodiversity and a balanced supply of green spaces?

In the last three decades China faced a rapid urbanization process. It is expected that around 70% of the Chinese population will live in growing or new cities in 2025. The total urban population will then amount to 900 million people, nearly 250 million more than today. Germany also went through a renewed process of urbanization and re-densification during the last decade, and 75% of the German population live in cities currently, however, two third of them in small and medium size cities.



An old chestnut tree is protected as a natural icon in a construction site in Berlin.

Globally, urbanization is causing increased land consumption in the urban fringes and leads to re-densification, concentration and compaction processes in the city cores in China and Germany, while at the same time rural settlements are abandoned but usually not recultivated. While cities only occupy about 2% of the Earth's surface, the activities and needs of the population that lives and works there are responsible for nearly 80% of carbon emissions, 60% of water consumption and the use of three quarters of wood resources.

The urban ecosystems and the natural and near-natural surroundings of the population centers are often being subjected to massive pressure through changed land use claims and air, water and soil pollution, leading to impairment of the ecosystem functions and corresponding services.

Concentrating 50% of the world's population on 2% of the world's surface, urban areas provide tremendous opportunities for sustainable land use. The development of urban areas, including growing infrastructure, economic development and quality of life, is to be brought into harmony with the protection of nature and the environment. Many municipalities and initiatives worldwide are pursuing "green" urban development. The concepts that serve as a basis for this are diverse. Transparent, indicator-based evaluation systems are necessary to ensure that planning and action do indeed lead to increased sustainability and to a higher quality of life of the population in cities.

Global Urbanization – Status and Prediction

Region	Urbanization rate [%]			Percentage point increase [%]	
	2000	2010	2050	2000-2010	2010-2050
Europe	70.8	72.7	82.2	1.9	9.5
Asia	35.5	42.5	62.9	7.0	20.4
China	35.9	49.2	77.3	13.3	28.1
India	27.7	30.9	51.7	3.3	20.8
Africa	35.6	39.2	57.7	3.6	18.5
N. America	79.1	82.0	88.6	2.9	6.6
Latin Amer.	75.5	78.8	86.6	3.4	7.8

Source: Asian Development Bank (peak values in red)

- The world is "urbanizing"
- North America has the highest urbanization rate
- Asia has the highest speed in urban development (top speed: China)

Despite the differences urban structures in China and Germany, both countries face an ongoing trend towards urbanization and re-densification. Based on case study examples from China and Germany, this Policy Brief

aims to initiate a dialogue on options for integrating urban ecosystem services and biodiversity into policy and planning. We can learn a lot from each other regarding “green city development”.

Different Preconditions in Urbanization and Ecological Urban Development

	Germany	China
Urbanization rate	75% (2014)	54% (2014)
Economic growth	Low economic growth rates	High economic growth rates, decreasing
Urban growth	Slow urban growth by changes of internal urban structures, but still growing urban sprawl and urban land consumption of rural land.	Extreme urban growth with big regional differences and the target to reach an urbanization degree like in developed countries, and a ban (legal, but patchily enforced) on converting agricultural land into built-up area.
Steering of urbanization	Local, regional but also national steered urban development (e. g. national/regional/local strategies for different challenges like sustainability, climate change, loss of biodiversity, brownfield development). Decisions are based on competition on economic resources under governmental moderation. Competition of and among cities and surrounding communities.	Centrally steered urban development policy, competition on centrally distributed financial support, local and regional economic competition. Building of new cities and changing of old cities by radical transformation and building of new urban structures (infrastructure, housing stock, open spaces, industry etc.), but also conservation of cultural treasures. Recently, the radical transformation phenomenon slowed down.
Eco-city planning	At urban district level with NGOs and citizen involvement good examples have been realized based on urban ecological knowledge for decision making and design.	Centrally steered strategy of planning and implementation new cities as eco-cities without citizen participation, based only on fragmented urban ecological knowledge for design.
Green policy	Different approaches for green development in cities: national (e. g. TEEB City Study; White-Book “Urban Green”, national strategies [see above]), regional (e. g. regional plans), local (e. g. landscape, master plans for green, green/biodiversity strategies), supporting programs etc.	Powerful green policy and urban green extension in many cities based on high financial input in land, construction and management. Urban ecological space construction and environmental protection are more economically and administratively oriented, as opposed to ecological orientation.
Development of urban nature	Protection of existing urban nature, especially urban forests and wetlands for recreation and biodiversity. Partly development of new urban nature on brownfields (urban wilderness), in urban reconstruction processes. Development of green networks to connect green spaces and biotopes in the city with its surroundings (e. g. through tree-clad streets, green roofs).	Development of new urban nature, especially planting urban forests and new design of urban wetlands for recreation and biodiversity.

Shared challenges for the development of urban green spaces in China and Germany:

- leaf Changing from quantitative urban growth to qualitative growth and demand of coordinated development of urban agglomerations;
- leaf Optimizing the urban form and pattern for sustainability, reducing resource and land consumption and greening the cities;
- leaf Enhancing urban dwellers' benefits from urban nature and biodiversity by integrating them into decision making, design and management of urban planning;
- leaf Integrating ecological knowledge into decision making and urban design;
- leaf Using the approach of ecosystem services to develop nature-based solutions for approaching societal urban challenges such as climate change adaptation and resource consumption;
- leaf Developing methodological and practical approaches for strategic eco-city (“eco-civilization”) development using indicator-based evaluation of urban biodiversity and ecosystem services;
- leaf Meeting the challenges under the condition of reduced availability of local financial resources whilst simultaneously increasing complexity of urban planning.

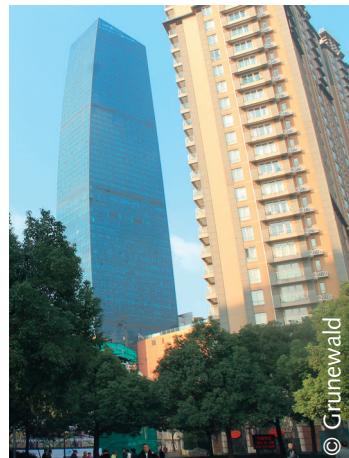
The capitals in comparison

	Beijing (2012) ¹	Berlin (2014) ²
Inhabitants (mill.)	17.3	3.5
Administrative area (km ²)	3,500	892
Population density (l./km ²)	5,000	4,000
Green area ³ (%)	46	44
m ² green space per capita	1	1
Nature protection area (ha/%)	137,880/8.4*	2,061/2.3
Number of plant species	2,708*	2,179

¹ www.newgeography.com (*after Nengwen Xiao 2015)

² www.stadtentwicklung.berlin.de

³ Forests, public green, waters, agricultural land



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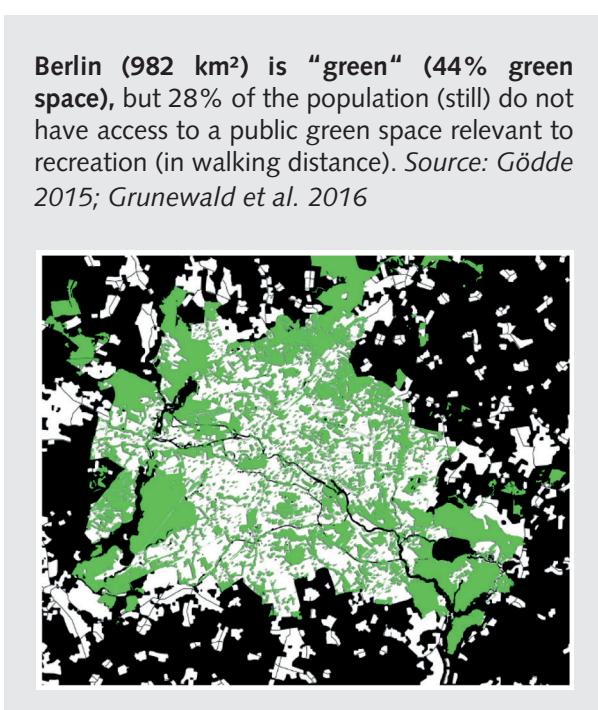
Small-scale habitats in Shanghai (left) and Dresden

Strategy: More “Green” – More Ecosystem Services – More Well-Being

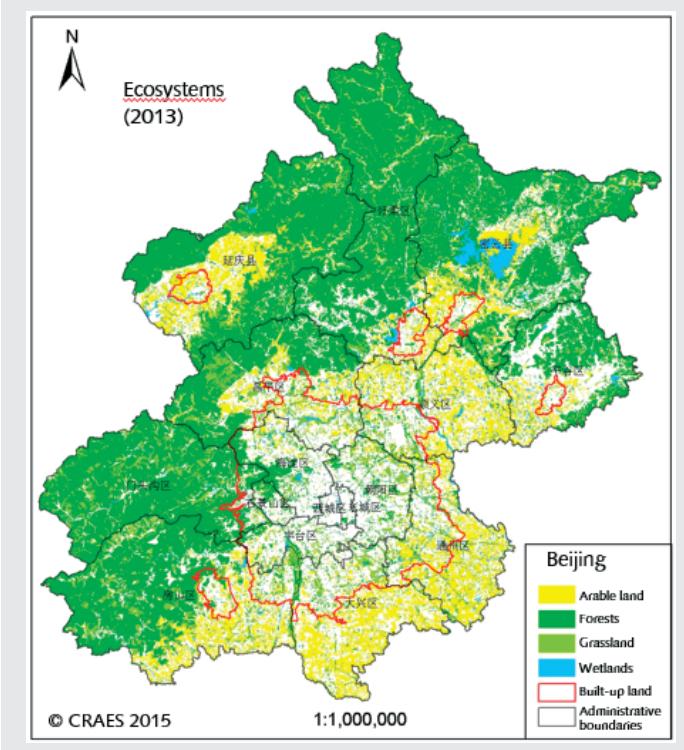
The elements of the green-blue infrastructure in the urban space (parks, gardens, city trees, lawns, river systems and lakes/ponds, city forests, small-scale green spaces in residential areas, roof and wall greening etc.) represent habitats for numerous species and provide a high variety of ecosystem services. They have a positive health impact and make the city more beautiful, but they also have positive microclimatic effects. Thanks to recreation in an environment which is close to nature or at least “green”, people can stimulate their immune system and maintain their performance. The health

system is less strained, labor productivity is maintained or enhanced. The beneficial health effects of experiential interaction with nature have been demonstrated in various studies (see references).

Beijing (3,500 km²) is also “green” (46% green space), but the spatial arrangement in relation to the residential areas is less favorable (78% live in the city center with little green and only 22% live in the satellite districts).



Berlin (982 km²) is “green” (44% green space), but 28% of the population (still) do not have access to a public green space relevant to recreation (in walking distance). Source: Gödde 2015; Grunewald et al. 2016



A clarification of the benefits urban residents gain from urban green spaces as well as control of urban green quality at the city and federal level are necessary to derive and pinpoint urban planning and nature

conservation strategies in this context. In this light, due to its integrated approach the concept of ecosystem services is gaining increased popularity in the global environmental debate.

"Green" – that means ecologically sustainable city development

Green Infrastructure (GI) is a strategically planned network of natural and near-natural areas which provide a wide range of ecosystem services and biodiversity preservation opportunities.

The terms "**Urban forests**" (China) and "**Urban Green Space**" (UGS, Germany) refer to natural areas, urban forests, parks, green areas, public gardens and roadside trees and bodies of water; they are part of the Green Infrastructure.

Urban Ecosystem Services (UES) are direct and indirect contributions of urban green spaces and forests to human well-being.

Urban Biodiversity is characterized on the one hand by a specific, rich, partially valuable diversity of habitats and species; on the other hand, it is threatened by sealing of soil, fragmentation, disturbance and land use pressure due to ongoing urbanization.

"Green Matters" – Demonstrate the Values of Urban Green!

The assessment of urban biodiversity and Urban Ecosystem Services (UES) enables the integration of its values into policy and planning:

Microclimatic regulation: Urban green spaces can significantly reduce the 'urban heat island effect'. Data from Shanghai indicate that the cooling effect of a park is equivalent to 1500 air-conditioning systems with 1.5 KW (Zhou et al. 2009).

Habitat service: An important feature of urban areas is the mosaic of habitats and a surprisingly high diversity of plant and animal species. In addition to the inherent values of biodiversity, this UES offers significant benefits for citizens, for example, for aesthetics and environmental education, and as a physical and mental health promoting factor.

Air pollution regulation: It is well known that urban vegetation in assemblages which fix filtered substances can improve the air quality by filtering particulate matter (PM_{10}), nitrogen oxides (NO_2) and sulfur dioxide (SO_2).

Run-off regulation: Nature-based solutions in the city contribute to the improvement of water infiltration, water storage and runoff retention and thus help to protect against floods by damping the amplitudes.

Accessibility of public green spaces as cultural UES: Ecosystems in cities deliver services for the residents regarding the experience of nature, recreational activities, relaxation, outdoor dancing and sports, and aesthetics. In particular, they contribute to the psychological and

physical regeneration of the population and are therefore in demand.

To demonstrate the benefits, quantification is extremely helpful (see the microclimatic effects in Shanghai above). Derkzen et al. (2015) offer some examples of UES quantification for three selected green-types:

	Woodland	Shrubs	Herbaceous
Air purification ($gm^{-2}a^{-1}$)	2.7	2.1	0.9
Carbon storage (kgm^{-2})	15.6	6.7	0.2
Noise reduction (dB(A) $100m^{-2}$)	1.1	1.6	0.4
Run-off retention (Lm^{-2})	8.7	7.3	8.0
Cooling (UGS fraction: weight)	1.0	1.0	0.5

Comparing these data with potential technical alternatives clearly indicates that elements of green infrastructure are not only ecologically and socially desirable, but often economically beneficial, providing services at lower costs than technical solutions or healthcare.

How much "green" is enough?

The establishment of target values is difficult. In addition to the proportion and volume of green space, spatial arrangement, accessibility and other qualitative aspects play a key a role.

The Right Direction is Realised, but Implementation is a Process

A "green" urban development figures prominently on the political agenda in China and Germany. This vision needs to be underpinned by clear and operational objectives (targets, indicators etc.). Good approaches exist; for instance:

- leaf The National Biodiversity Strategy in Germany (2007) with the demand that "By 2020, the greening of settlements is ... clearly increased. Publicly accessible green spaces with varying qualities and functions are usually available within walking distance."

In March 2012 the Berlin Senate created and adopted Berlin's strategy for biodiversity. Four objectives with 38 strategic goals have been identified. One such goal, for instance, is that for each resident there should be at least 6m² green space available in the city of Berlin.

In China, more than 500 'ecological cities (counties)' and demonstration projects are under construction. Flagship projects such as the Sino-Singapore Tianjin Eco-city Project were established. In Shanghai up to 20,000 ha of additional green space will be created by 2020; the city of Beijing has planted 1 million trees.

Conclusion

The "Compact city in an ecological network" – as proposed by the Dresden city authorities – could be a future slogan. But the implementation of green spaces is often in conflict with competing urban land use demands, limited areas for (new) green spaces, lacking design principles and systemic strategies, sectoral views on development and maintenance, and limited public financial resources. Rethinking ("learning from mistakes") is needed, e.g. in China from a focus on designed urban parks to greening concepts that fulfill diverse ecological functions.

Implementing the following 12 rules for policy action will help city developers progress towards green cities:

- leaf Reduction of urban land consumption and recycling of urban land (renaturation of brownfields, unsealing);
- leaf New urban development only under consideration of ecological targets;
- leaf Ecological compensation for reduced open spaces and impacts on biodiversity in the city area;
- leaf Assessment and evaluation of ecosystem services of arable land in sub-urban and peri-urban areas;

leaf Learning from good realized examples (greening measures, renaturation, whole city green development etc.);

leaf Long-term monitoring; indicator-based and target-oriented measuring of results;

leaf Integration of all forms of urban vegetation into a coherent green-blue infrastructure network strategy;

leaf Protection and development of urban waters and wetlands by allowing natural development;

leaf Natural development of existing urban forests and planting of new ones;

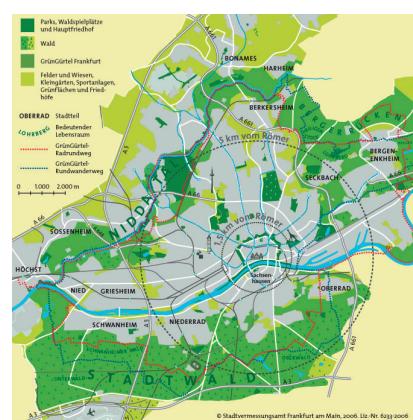
leaf Integration of natural succession into urban green systems/urban green infrastructure, allowing dynamics;

leaf Protecting/keeping a wide variety of small-scale green spaces (e. g. backyard greening, roof and wall greening, pocket parks in and near residential areas);

leaf Interlinking the urban grey (street network, construction areas) with urban green for compact and green cities.



Model of Shanghai in the Shanghai Urban Planning Exhibition Center



Green belt plan Frankfurt a. M.

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The author team is preparing the “GreenCities Study” (Towards Green Cities: The Values of Urban Biodiversity and Ecosystem Services in China and Germany), SpringerBriefs, ca. 100 pages (English with German and Chinese summary).



Facets of urban green, grey and blue in Chengdu, Berlin, Beijing, Dresden (from left to right; © Grunewald/Kümper-Schlake)

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